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Effect of UV/ozone treatment on surface hydrophilicity and humidity sensing properties of PVDF-BaTiO3 composite films

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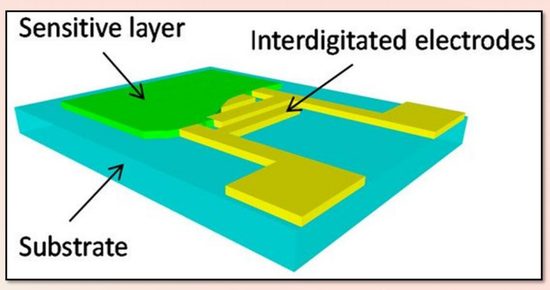
Abstract

In this research work, we have studied the impact of UV/ozone treatment on the hydrophilicity of the PVDF-$BaTiO_3$ nanocomposite film. We have prepared the nanocomposite solution by mixing PVDF (2.5 wt% kept constant) and $BaTiO_3$ nanoparticles (0.25 wt%, 0.5 wt%, and 1 wt% varied concentration).The spin coating technique has been used to deposit the nanocomposite film on the Interdigitated ITO electrode.

Figure 1: Schematic diagram of the spin coated moisture sensors.

The resistive humidity sensor detects water vapors that directly influence the electrical conductivity of the sensing film. Impedance varies when the water vapors strongly concentrate the surface of the sensing film.



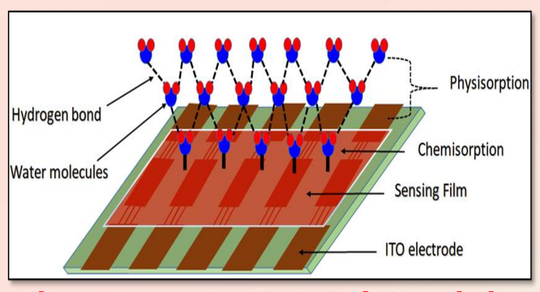


Figure 2: Schematic diagram of Resistive humidity sensor using an interdigitated electrode design structure [1].

Experimental Setup

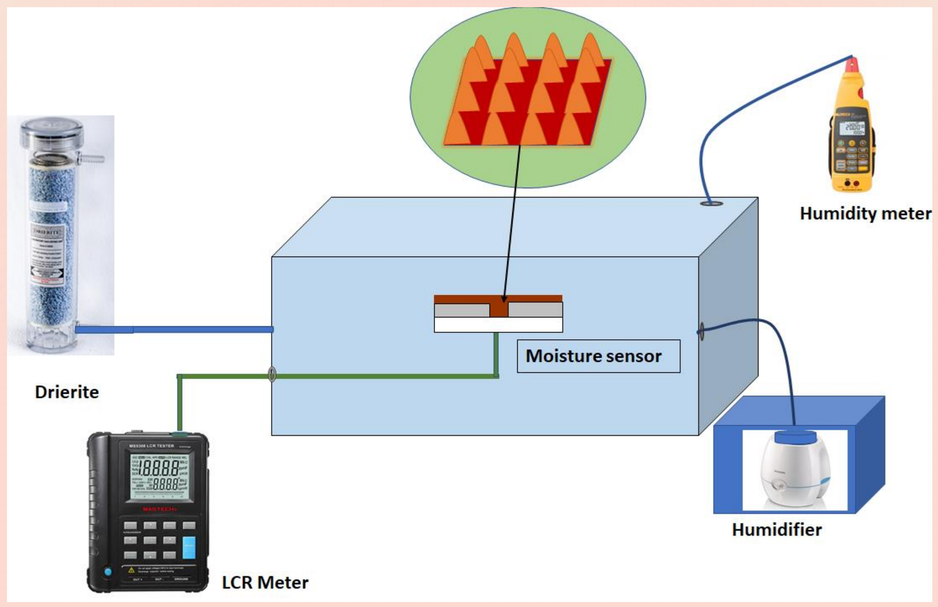


Figure 2: Schematic diagram of electrical characterization setup.

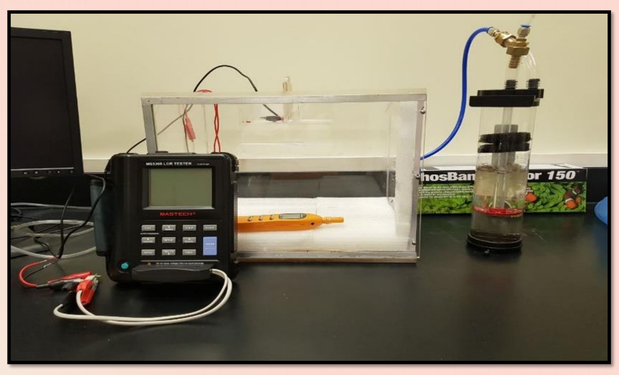


Figure 3: Electrical characterization setup.

Figure 4: Spin Coating machine.

Results & Discussion

AFM and Contact Angle Analysis

The Surface analysis of PVDF:$BaTiO_3$ composite films done by AFM analysis. PVDF:$BaTiO_3$ (2.5 wt%- 0.5 wt%) composite films exposed to UV/Ozone treatment from 0 min to 10 min. By applying UV/Ozone light the surface roughness of the film decreases as expected. However, the contact angle measurement shows that as we increase the exposing time for UV/Ozone treatment the nanocomposite film becomes more hydrophilic.

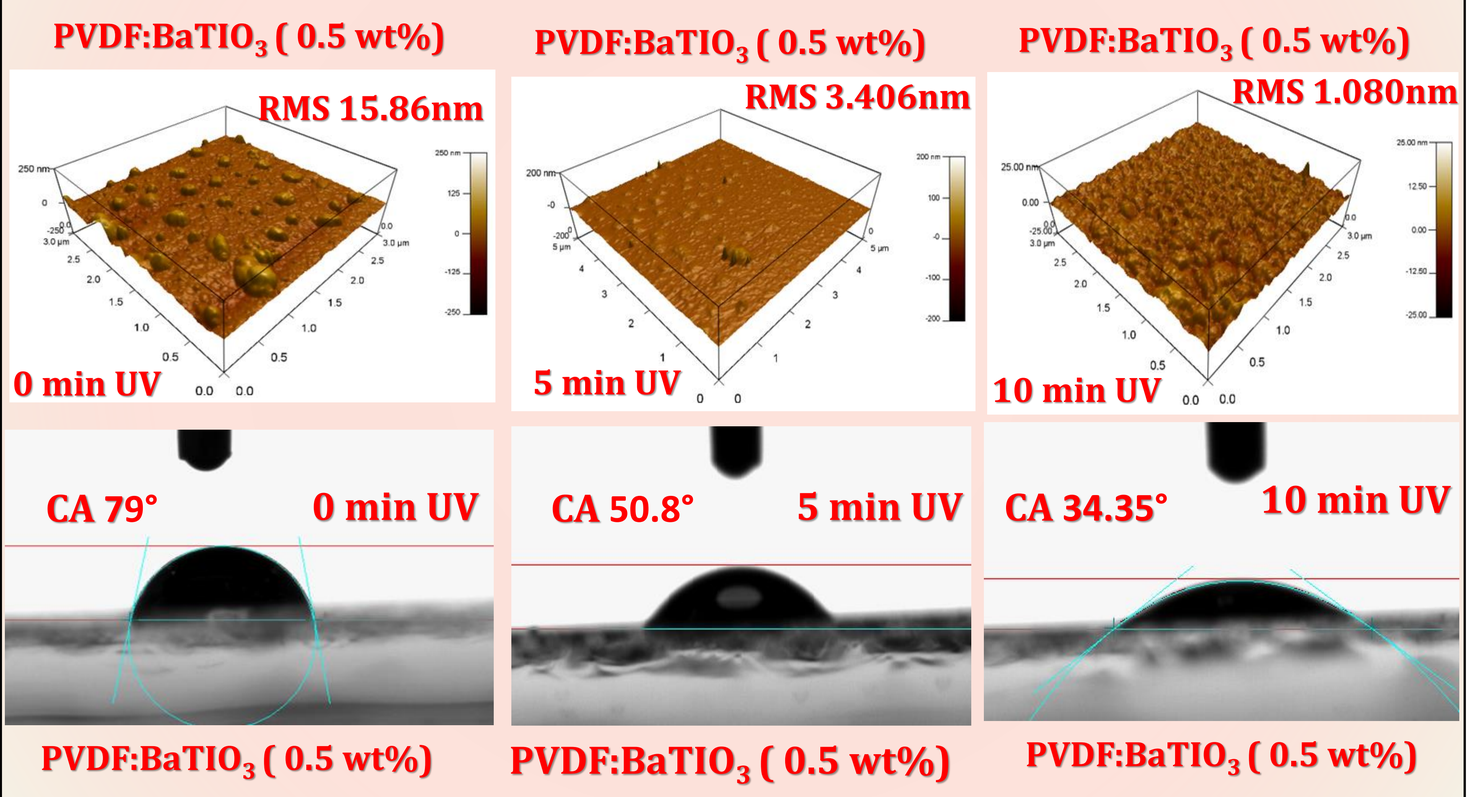


Figure5: AFM analysis and contact angle measurement of PVDF:$BaTiO_3$ composite film exposing to UV/Ozone treatment for 0 min to 10 min.

TGA and Electrical Response

Thermal stability analysis of PVDF and PVDF:$BaTiO_3$ composite done on TGA analysis. Capacitive moisture sensors based on PVDF-$BaTIO_3$ composite demonstrate high sensitivity and linear response as compared to PVDF film alone.

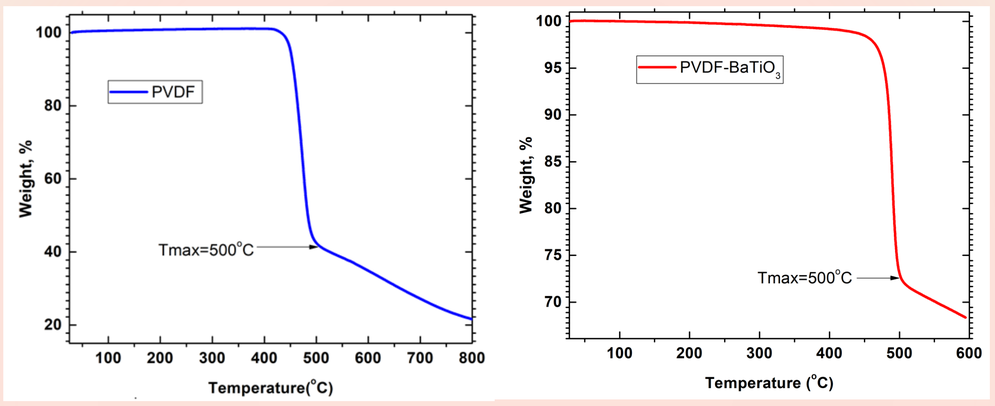


Figure6: TGA analysis of PVDF and PVDF-$BaTiO_3$ composite film

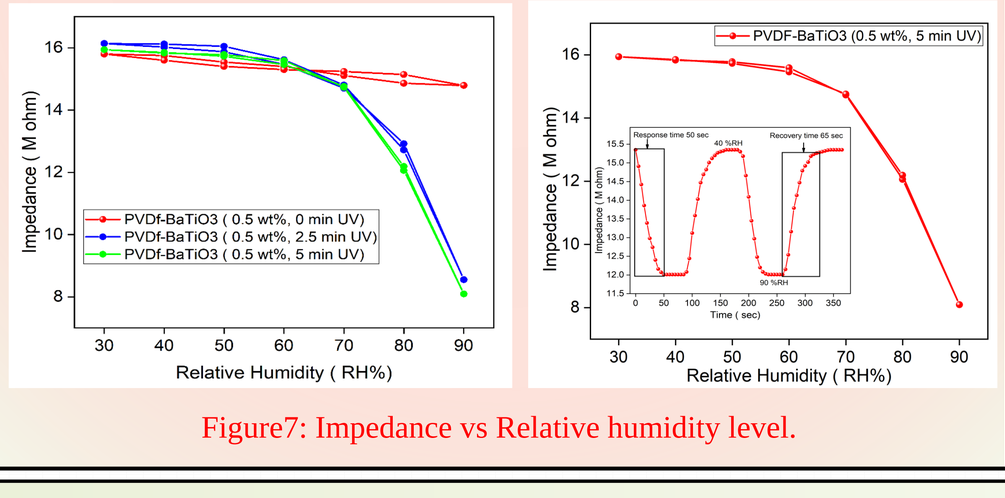


Figure7: Impedance vs Relative humidity level.

Concluding remarks:

The PVDF-$BaTiO_3$ composite film exposed to UV/ozone light from 2.5 min to 10min. The UV/ozone treatment of the PVDF-$BaTiO_3$ nanocomposite film improves the sensing film's hydrophilicity. The TGA analysis reveals that PVDF-$BaTIO_3$ composite are more stable as compared to PVDF film alone. The PVDF - $BaTiO_3$ (0.5 wt%) impedance sensor with 5 min UV/ozone treatment shows higher sensitivity and small hysteresis (~1.65%) over the whole investigated RH range. The response and recovery times of the fabricated PVDF-$BaTiO_3$ Impedance humidity sensor are calculated to be 50 s and 65 s, respectively.

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